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THE BRITISH ASSOCIATION.

THE meeting of the Association which has just closed has certainly been a successful one. It is true that no papers of any striking merit have been read before the sections; scientific men, however, do not look to the British Association for the publication of important original discoveries, but rather as a pleasant reunion where old friends meet, new acquaintances are made, and pleasant excursions indulged in. Looked at from this point of view, there cannot be a doubt that the meeting has been an eminent success. The attendance has been, we believe, the third largest in the history of the Association. The hospitalities and the festivities have been unsurpassed, and the excursions have been most numerous and varied; indeed, it would almost appear as though the British Association meets more for the recreation of its members than for the advancement of science. Considering the fact that the majority of those attending the meetings of the Association have had no special training in science, but are interested and anxious to be instructed in its mysteries, we think the Council of the Association might devise some scheme whereby these annual gatherings could be made of wider interest and more permanent value. Every one who attends the meetings is familiar with the groups of men and women who wander aimlessly from section to section, eager to find something they can understand to carry away with them as a reminiscence of the sections they have attended; hence it comes to pass that when Sir John Lubbock discourses on ants, or Captain Burton on the land of Midian, or Miss Todd on the boarding out of pauper children, such sections become inconveniently overcrowded, full newspaper reports appear, and the public go away with the impression that such papers have been the chief events of the meeting. What the British Association really might do in the way of instructing the public in the progress of the different branches of science, it does not do, except so far as the evening lectures or the presidential addresses concern themselves with this topic. From various quarters similar remarks have been urged upon the Council of the Association; and we trust that, ere long, some action may be taken upon this important matter. Another matter demanding attention is the more expeditious publication of an authorative report of the proceedings of the sections, which, we imagine, might be done without any very great cost if undertaken in conjunction with the local newspaper press.

THE ROYAL DUBLIN SOCIETY CONVERSAZIONE.

One of the most striking features of the meeting was, perhaps, the brilliant and interesting *soirée* given by the Royal Dublin Society on August 15th. Space will not allow us to describe the numerous instruments exhibited and experiments that were shown, but, as concerns electrical apparatus, the most novel was a beautiful and complicated arrangement devised by Mr. J. E. H. Gordon, the newly-elected assistant secretary of the Association, for the purpose of measuring the specific inductive capacity of dielectrics. We may here say that Mr. Gordon employs an induction coil, the secondary current of which can be made and broken by a special contrivance with extreme rapidity, to maintain the constant electrification of one plate of the condenser, between the surfaces of which is placed the paraffin or other substance whose inductive capacity is to be determined.

Mr. Gordon, who also exhibited his electrical self-registering anemometer, had his instruments in actual working order at this *soirée*.

The President of the Association, Dr. Spottiswoode, sent for exhibition his apparatus for analysing the stratified discharge in vacuum tubes by means of a rotating mirror; also an arrangement for rapidly shifting the terminal from one end to another of a vacuum-tube, together with an apparatus for altering the resistance in the path of the secondary discharge, consisting of a long spiral glass tube, containing mercury in the lower part, and some liquid non-conductor above, the relative quantity of the two liquids being adjustable at pleasure. Dr. Spottiswoode also contributed one of Dr. Muirhead's large condensers, which, being once charged from a large induction coil, gives out a stream of electricity, illuminating a vacuum-tube for several minutes.

Mr. H. Yeates, of London, sent a very large induction coil, the secondary wire of which is unusually thick, and the spark particularly "fat."

Mr. S. Yeates, of Dublin, exhibited, at work, one of his new form of electrically controlled clocks, which is on the same system as Ritchie's, but with the coil fixed, and the magnet forming the bob of the pendulum, both coil and magnet being of a different and better construction to those ordinarily in use.

Mr. Yeates also showed his ingenious and useful electrical rain gauge. Mr. Ladd brought an excellent form of Byrne's pneumatic bichromate of potash battery, adapted for surgical use; and also exhibited Edmund's phonoscope, an apparatus for making visible, by means of a rotating vacuum tube, the various vibrations imparted by the voice to the disc of a telephone. In this arrangement the iron telephone disc really forms the contact-breaker of a small induction coil, which is employed to illuminate a small vacuum tube kept in continuous rotation, thus presenting the appearance of the ordinary Gassiot star. When a sustained sound is uttered in front of the mouthpiece of the telephone, the star assumes a definite pattern, which varies when a note of different pitch is employed. Mr. Ladd also showed an electrical apparatus capable of reversing a current twenty-seven thousand times a minute.

In a separate room Mr. Stoney, the honorary secretary of the Royal Dublin Society, exhibited the beautiful absorption spectrum of chloro-chromic anhydride, with a spectroscope of unusually high dispersive power. In another room, Professor Barrett showed his discovery of the effect of entirely inaudible vibrations upon sensitive flames.

Mr. Wigham, of the well-known firm of Edmundson's, made different parts of the extensive and splendid buildings of the Royal Dublin Society brilliant with several electric lights derived from

Gramme machines driven by gas and steam engines. The same enterprising firm also sent a large model of the Galleyhead Lighthouse, and the piercing sounds of a gigantic Irish fog siren, sent by the same firm, were heard at intervals from the courtyard. Nor must we forget to mention the large punkah, swung by compressed air, the invention of Lord Rosse's brother, the Hon. R. C. Parsons, and the splendid show of carnivorous plants sent by Dr. Moore, from the Dublin Botanical Gardens.

Electro-type reproductions of all the most interesting objects in the loan collection of scientific apparatus were lent by the authorities of the South Kensington Museum, together with several cases of interesting art objects. A vast array of microscopes, with some remarkable microscopic objects, were exhibited by different members of the Dublin Microscopic Club, and lastly, a fine display of art objects and of exotic plants, lent by local friends, embellished the various rooms.

ADDRESS OF WILLIAM SPOTTISWOODE, ESQ., M.A., D.C.L., L.L.D., F.R.S., F.R.A.S., F.R.G.S., PRESIDENT.

(Continued from page 341.)

Now the process whereby we have passed from the possible to the impossible, and again repassed to the possible (namely, the shifting of the starting point) is a perfectly continuous one, while the conditions of the problem as stated above have abruptly changed. If, however, we replace the idea of a line touching by that of a line cutting the circle, and the distance of the point of contact by the distances at which the line is intercepted by the curve, it will easily be seen that the latter includes the former as a limiting case, when the cutting line is turned about the starting point until it coincides with the tangent itself. And further, that the two intercepts have a perfectly distinct and intelligible meaning whether the point be outside or inside the area. The only difference is that in the first case the intercepts are measured in the same direction; in the latter in opposite directions.

The foregoing instance has shown one purpose which these imaginaries may serve, viz., as marks indicating a limit to a particular condition of things, to the application of a particular law, or pointing out a stage where a more comprehensive law is required. To attain to such a law we must, as in the instance of the circle and tangent, reconsider our statement of the problem; we must go back to the principle from which we set out, and ascertain whether it may not be modified or enlarged. And even if in any particular investigation, wherein imaginaries have occurred, the most comprehensive statement of the problem of which we are at present capable fails to give an actual representation of these quantities; if they must for the present be relegated to the category of imaginaries; it still does not follow that we may not at some future time find a law which will endow them with reality, nor that in the meantime we need hesitate to employ them, in accordance with the great principle of continuity, for bringing out correct results.

If, moreover, both in Geometry and in Algebra we occasionally make use of points or of quantities, which from our present outlook have no real existence, which can neither be delineated in space of which we have experience, nor measured by scale as we count measurement; if these imaginaries, as they are termed, are called up by legitimate processes of our science; if they serve the purpose not merely of suggesting ideas, but of actually conducting us to practical conclusions; if all this be true in abstract science, I may perhaps be allowed to point out, in illustration of my argument, that in Art unreal forms are frequently used for suggesting ideas, for conveying a meaning for which no others seem to be suitable or adequate. Are not forms unknown to Biology, situations incompatible with gravitation, positions which challenge not merely the stability but even the possibility of equilibrium—are not these the very means to which the artist often has recourse in order to convey his meaning and to fulfil his mission? Who that has ever revelled in the ornamentation of the Renaissance, in the extraordinary transitions from the animal to the vegetable, from faunic to floral forms, and from these again to almost purely geometric curves, who has not felt that these imaginaries have a claim to recognition very similar to that of their congeners in mathematics? How is it that the grotesque paintings of the Middle Ages, the fantastic sculpture of remote nations, and even the rude art of the pre-historic past, still impress us, and have an interest over and above their antiquarian value; unless it be that they are symbols which, although hard of interpretation when taken alone, are yet capable from a more comprehensive point of view of leading us mentally to something beyond themselves, and to truths which, although reached through them, have a reality scarcely to be attributed to their outward forms?

Again, if we turn from Art to Letters, truth to nature and to fact is undoubtedly a characteristic of sterling literature; and yet in the delineation of outward nature itself, still more in that of feelings and affections, of the secret parts of character and motives of conduct, it frequently happens that the writer is driven to imagery, to an analogy, or even to a paradox, in order to give utterance to that of which there is no direct counterpart in recognised speech. And yet which of us cannot find a meaning for these literary figures, an inward response to imaginative poetry, to social fiction, or even to those tales of giant and fairyland written, it is supposed, only for the nursery or schoolroom? But in order thus to reanimate these things with a meaning beyond that of the mere words, have we not to reconsider our first position, to enlarge the ideas with which we started; have we not to cast about for some thing which is common to the idea conveyed and to the subject actually described, and to seek for the sympathetic spring which underlies both; have we not, like the mathematician, to go back as it were to some first principles, or, as it is pleasanter to describe it, to become again as a little child?

Passing to the second of the three methods, viz., that of Manifold Space, it may first be remarked that our whole experience of space is in three dimensions, viz., of that which has length, breadth, and thickness; and if for certain purposes we restrict our ideas to two dimensions as in plane geometry, or to one dimension as in the division of a straight line, we do this only by consciously and of deliberate purpose setting aside, but not annihilating, the remaining one or two dimensions. Negation, as Hegel has justly remarked, implies that which is negatived, or, as he expresses it, affirms the opposite. It is by abstraction from previous experience, by a limitation of its results, and not by any independent process, that we arrive at the idea of space whose dimensions are less than three.

It is doubtless on this account that problems in plane geometry which, although capable of solution on their own account, become much more intelligible, more easy of extension, if viewed in connexion with solid space, and as special cases of corresponding problems in solid geometry. So eminently is this the case, that the very language of the more general method often leads us almost intuitively to conclusions which, from the more restricted point of view, require long and laborious proof. Such a change in the base of operations has, in fact, been successfully made in geometry of two dimensions, and although

we have not the same experimental data for the further steps, yet neither the modes of reasoning, nor the validity of its conclusions, are in any way affected by applying an analogous mental process to geometry of three dimensions; and by regarding figures in space of three dimensions as sections of figures in space of four, in the same way that figures in plano are sometimes considered as sections of figures in solid space. The addition of a fourth dimension to space not only extends the actual properties of geometrical figures, but it also adds new properties which are often useful for the purposes of transformation or of proof. Thus it has recently been shown that in four dimensions a closed material shell could be turned inside out by simple flexure, without either stretching or tearing; and that in such a space it is impossible to tie a knot.

Again, the solution of problems in geometry is often effected by means of algebra; and as three measurements, or co-ordinates, as they are called, determine the position of a point in space, so do three letters or measurable quantities serve for the same purpose in the language of algebra. Now, many algebraical problems involving three unknown or variable quantities admit of being generalised so as to give problems involving many such quantities. And as, on the one hand, to every algebraical problem involving unknown quantities or variables by ones, or by twos, or by threes, there corresponds a problem in geometry of one or of two or of three dimensions; so on the other it may be said that to every algebraical problem involving many variables there corresponds a problem in geometry of many dimensions.

There is, however, another aspect under which even ordinary space presents to us a four-fold, or indeed a manifold, character. In modern Physics, space is regarded not as a vacuum in which bodies are placed and forces have play, but rather as a plenum with which matter is co-extensive. And from a physical point of view the properties of space are the properties of matter, or of the medium which fills it. Similarly from a mathematical point of view, space may be regarded as a *locus in quo*, as a plenum, filled with those elements of geometrical magnitude which we take as fundamental. These elements need not always be the same. For different purposes different elements may be chosen; and upon the degree of complexity of the subject of our choice will depend the internal structure or mani-foldness of space.

Thus, beginning with the simplest case, a point may have any singly infinite multitude of positions in a line, which gives a one-fold system of points in a line. The line may revolve in a plane about any one of its points, giving a two-fold system of points in a plane; and the plane may revolve about any one of the lines, giving a three-fold system of points in space.

Suppose, however, that we take a straight line as our element, and conceive space as filled with such lines. This will be the case if we take two planes, *e.g.*, two parallel planes, and join every point in one with every point in the other. Now the points in a plane form a two-fold system, and it therefore follows that the system of lines is four-fold; in other words, space regarded as a plenum of lines is four-fold. The same result follows from the consideration that the lines in a plane, and the planes through a point, are each two-fold.

Again, if we take a sphere as our element, we can through any point as a centre draw a singly infinite number of spheres, but the number of such centres is triply infinite: hence space as a plenum of spheres is four-fold. And, generally, space as a plenum of surface has a manifoldness equal to the number of constants required to determine the surface. Although it would be beyond our present purpose to attempt to pursue the subject further, it should not pass unnoticed that the identity in the four-fold character of space, as derived on the one hand from a system of straight lines, and on the other from a system of spheres, is intimately connected with the principles established by Sophus Lie in his researches on the correlation of these figures.

If we take a circle as our element we can around any point in a plane as a centre draw a singly infinite system of circles; but the number of such centres in a plane is doubly infinite; hence the circles in a plane form a three-fold system, and as the planes in space form a three-fold system, it follows that space as a plenum of circles is six-fold.

Again, if we take a circle as our element, we may regard it as a section either of a sphere or of a right cone (given except in position) by a plane perpendicular to the axis. In the former case the position of the centre is three-fold; the directions of a plane, like that of a pencil of lines perpendicular thereto, two-fold; and the radius of the sphere one-fold; six-fold in all. In the latter case, the position of the vertex is three-fold; the direction of the axis two-fold; and the distance of the plane of section one-fold, six-fold in all, as before. Hence space as a plenum of circles is six-fold.

Similarly, if we take a conic as our element we may regard it as a section of a right cone (given except in position) by a plane. If the nature of the conic be defined, the plane of section will be inclined at a fixed angle to the axis; otherwise it will be free to take any inclination whatever. This being so, the position of the vertex will be three-fold; the direction of the axis two-fold; the distance of the plane of section from the vertex one-fold; and the direction of that plane one-fold if the conic be defined, two-fold if it be not defined. Hence, space as a plenum of definite conics will be seven-fold, as a plenum of conics in general eight-fold. And so on for curves of higher degrees.

This is, in fact, the whole story and mystery of manifold space. It is not seriously regarded as a reality in the same sense as ordinary space; it is a mode of representation, or a method which, having served its purpose, vanishes from the scene. Like a rainbow, if we try to grasp it, it eludes our very touch; but, like a rainbow, it arises out of real conditions of known and tangible quantities, and if rightly apprehended it is a true and valuable expression of natural laws, and serves a definite purpose in the science of which it forms part.

Again, if we seek a counterpart of this in common life, I might remind you that perspective in drawing is itself a method not altogether dissimilar to that of which I have been speaking; and that the third dimension of space, as represented in a picture, has its origin in the painter's mind, and is due to his skill, but has no real existence upon the canvas which is the groundwork of his art. Or again, turning to literature, when in legendary tales, or in works of fiction, things past and future are pictured as present, has not the poetic fancy correlated time with the three dimensions of space, and brought all alike to a common focus? Or once more, when space already filled with material substances is mentally peopled with immaterial beings, may not the imagination be regarded as having added a new element to the capacity of space, a fourth dimension of which there is no evidence in experimental fact?

The third method proposed for special remark is that which has been termed Non-Euclidean Geometry; and the train of reasoning which has led to it may be described in general terms as follows: some of the properties of space which on account of their simplicity, theoretical as well as practical, have, in constructing the ordinary system of geometry, been considered as fundamental, are now seen to be particular cases of more general properties. Thus a plane surface, and a straight line, may be regarded as special instances of surfaces and lines whose curvature is everywhere uniform or constant. And it is perhaps not difficult to see that, when the special notions of flatness and straightness are abandoned, many properties of geometrical figures which we are in the habit of

regarding as fundamental will undergo profound modification. Thus a plane may be considered as a special case of the sphere, viz., the limit to which a sphere approaches when its radius is increased without limit. But even this consideration trenches upon an elementary proposition relating to one of the simplest of geometrical figures. In plane triangles the interior angles are together equal to two right angles; but in triangles traced on the surface of a sphere this proposition does not hold good. To this, other instances might be added.

Further, these modifications may affect not only our ideas of particular geometrical figures, but the very axioms of the Science itself. Thus, the idea, which in fact lies at the foundation of Euclid's method, viz., that a geometrical figure may be moved in space without change of size or alteration of form, entirely falls away, or becomes only approximate in a space wherein dimension and form are dependent upon position. For instance, if we consider merely the case of figures traced on a flattened globe like the earth's surface, or upon an eggshell, such figures cannot be made to slide upon the surface without change of form, as is the case with figures traced upon a plane or even upon a sphere. But, further still, these generalisations are not restricted to the case of figures traced upon a surface; they may apply also to solid figures in a space whose very configuration varies from point to point. We may, for instance imagine a space in which our rule or scale of measurement varies as it extends, or as it moves about, in one direction or another; a space, in fact, whose geometric density is not uniformly distributed. Thus we might picture to ourselves such a space as a field having a more or less complicated distribution of temperature, and our scale as a rod instantaneously susceptible of expansion or contraction under the influence of heat: or we might suppose space to be even crystalline in its geometric formation, and our scale and measuring instruments to accept the structure of the locality in which they are applied. These ideas are doubtless difficult of apprehension, at all events at the outset; but Helmholtz has pointed out a very familiar phenomenon which may be regarded as a diagram of such a kind of space. The picture formed by reflection from a plane mirror may be taken as a correct representation of ordinary space, in which subject to the usual laws of perspective, every object appears in the same form and of the same dimensions whatever be its position. In like manner the picture formed by reflection from a curved mirror may be regarded as the representation of a space wherein dimension and form are dependent upon position. Thus in an ordinary convex mirror objects appear smaller as they recede laterally from the centre of the picture; straight lines become curved; objects infinitely distant in front of the mirror appear at a distance only equal to the focal length behind. And by suitable modifications in the curvature of the mirror, representations could similarly be obtained of space of various configurations.

The diversity in kind of these spaces is of course infinite; they vary with the mode in which we generalise our conceptions of ordinary space; but upon each as a basis it is possible to construct a consistent system of geometry, whose laws, as a matter of strict reasoning, have a validity and truth not inferior to those with which we are habitually familiar. Such systems having been actually constructed the question has not unnaturally been asked, whether there is anything in nature or in the outer world to which they correspond; whether, admitting that for our limited experience ordinary geometry amply suffices, we may understand that for powers more extensive in range or more minute in definition some more general scheme would be requisite? Thus, for example, although the one may serve for the solar system, is it legitimate to suppose that it may fail to apply at distances reaching to the fixed stars, or to regions beyond? Or, again, if our vision could discern the minute configurations of portions of space, which to our ordinary powers appear infinitesimally small, should we expect to find that all our usual Geometry is but a special case, sufficient indeed for daily use, but after all only a rough approximation to a truer although perhaps more complicated scheme? Traces of these questions are in fact to be found in the writings of some of our greatest and most original mathematicians. Gauss, Riemann, and Helmholtz have thrown out suggestions radiating as it were in these various directions from a common centre; while Cayley, Sylvester, and Clifford in this country, Klein in Germany, Lobatcheffsky in Russia, Bolyai in Hungary, and Beltrami in Italy, with many others have reflected kindred ideas with all the modifications due to the chromatic dispersion of their individual minds. But to the main question the answer must be in the negative. And, to use the words of Newton, since "Geometry has its foundation in mechanical practice," the same must be the answer until our experience is different from what it now is. And yet, all this notwithstanding, generalised conceptions of space are not without their practical utility. The principle of representing space of one kind by that of another, and figures belonging to one by their analogues in the other, is not only recognised as legitimate in pure mathematics, but has long ago found its application in cartography. In maps or charts, geographical positions, the contour of coasts, and other features, belonging in reality to the Earth's surface, are represented on the flat; and to each mode of representation, or projection as it is called, there corresponds a special correlation between the spheroid and the plane. To this might perhaps be added, the method of descriptive geometry, and all similar processes in use by engineers, both military and civil.

(To be continued.)

MOTIONS PRODUCED BY DILUTE ACIDS ON SOME AMALGAM SURFACES.

By ROBERT SABINE.

Abstract of paper read before the British Association, at Dublin August 15th.

THE author finds, when a drop of very dilute acid is placed upon the clean and newly filtered surface of a rather rich amalgam of some metal which is positive to mercury, that the drop does not lie still, as it would do upon pure mercury, but sets itself into an irregular jerky motion. This is the case with copper, zinc, antimony, tin, and lead amalgams. But if, instead of these amalgams, those of platinum, gold, and silver are used—these latter metals being negative to mercury—the drop of acid-water lies quite still. The acids tried were sulphuric, hydrochloric, oxalic, and acetic, which behaved similarly but in different degrees.

When the experiment is made in an atmosphere of oxygen, the movements upon the amalgams of the positive metals are increased; but in hydrogen, carbonic-acid, nitrogen, and coal-gas, the motions are instantly arrested.

The author concludes that the motions result from an alternate play of deoxidation of the mercury underneath the acid by electrolysis, due to the currents of small floating particles of the positive metal, causing the drop to contract, and of oxidation of the surface outside the acid drop, causing it to re-expand.

ON RECENT ADVANCES IN TELEGRAPHY.

By WILLIAM HENRY PREECE, Mem. Inst. C.E., &c., &c.

Read before the British Association at Dublin, August 19, 1878.

THE overpowering sensation produced by the telephone and other acoustic instruments that have followed in its wake has led many people to imagine that improvement in telegraphy has ceased, at least in this country. It has been publicly stated by very high authorities that, since the transfer of the telegraphs to the State, invention in that art has left the shores of the United Kingdom and flown to those of America. Moreover, it has been intimated that the monopoly in telegraphy possessed by the State has checked improvement.

Such statements are made in ignorance of the facts. Greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration. Inventions have, it is true, found their way from America; but they have also travelled in the opposite direction, and have taken root there. Indeed, improvement in telegraphy was never more active in England than it has been since the Government has managed the business.

The object of this paper is to prove the above propositions.

Taking the improvements that have been made in telegraphs generally during recent periods, I will first of all deal with the receiving apparatus. The general feature of the apparatus used in Europe was eight years ago dependent on sight, while in America it was dependent on sound. In England we had (1) the needle instrument of Cooke and Wheatstone, which was and is still universally employed on our railways; (2) the Morse recording instrument, which is still the most generally-used instrument throughout Continental Europe; (3) the Hughes type printer; (4) the A B C or alphabetical instrument of Wheatstone; and (5) the bell instrument of Bright.

In America, though the type printer has been very largely used, the principal instrument for many years past has been the sounder.

The gradual exercise of that law of evolution—the survival of the fittest—is in England slowly replacing the Morse recorder by the more simple sounder. It has removed the type printer excepting in connexion with cables to the Continent. It has commenced to supplant the needles, which appeal to the eye by a method which appeals to the ears, in fact, a modified form of the bell—the first sound instrument ever introduced—and its general tendency is to reduce all apparatus to one stage of uniformity. Acoustic apparatus has proved itself to be more simple, more accurate, and more expeditious than visual apparatus, but its capacity is limited to the rate at which the ear can comprehend signals. Again, the speed is limited by that at which the hand can send and write, and the operations of sending at one end and writing at the other must be simultaneous, while recorded messages can wait, or they can be distributed among several writers. Hence all apparatus fixed on fast-speed circuits must necessarily remain visual, while all other ordinary apparatus will probably be acoustic.

The principal improvements that have been recently introduced in receiving apparatus have been S. A. Varley's and Spagnoletti's induced needles, to remedy the disturbances due to atmospheric electricity; Siemens' direct ink-writer, to remedy the irksomeness to the eye of the embossed paper of Morse; Wheatstone's A B C dial instrument, Sir W. Thomson's syphon recorder, and Varley's condenser, both of these being designed for expediting the rate of working through long submarine cables.

Bain's chemical recorder (reproduced after many years interment) for expediting the speed of automatic working through long circuits.

Neale's acoustic coil for assimilating the single needle and bell systems.

Bell's telephone, which, however, is at present employed only on a very limited scale in England.

With respect to sources of electricity. Innumerable improvements have been made in batteries, but two only need be named, which, for power, efficiency, and economy, far surpass all others, and are being very considerably employed in the United Kingdom, viz. :—

Leclanché's, where ammonic chloride and manganic peroxide are the principal exciting agents, and Fuller's, where Poggendorff's potassic bichromate solution is the exciting agent.

These two batteries are gradually replacing with great economy the Daniell form, hitherto so largely used.

In sources dependent upon motion in a magnetic field, such as Wild's, Siemens', and Gramme's machines, though experiments have been made, they have not yet shown themselves equal in efficiency to batteries for telegraphic purposes.

It seems, however, very desirable that so simple a form of energy as the motion of a steam engine or a turbine should be utilised as an electric machine, since probably it is the most economical form by which the necessary conversion can be made. In batteries the waste of energy is enormous.

In sources dependent on the conversion of heat into electricity, Clamond's thermo-electric pile, both in its original form and as modified by Leonard Wray, have been extensively experimented upon, but without any decided result. It is, however, worthy of record that for many weeks forty-three circuits were maintained in working order by one pile, in which the energy of gas jets was converted into currents of electricity.

It is perhaps in improvements in conductors that England has shone most. She has supplied the world with cables.

Her iron-clad ropes rest on the bottom of every sea, and her cable fleet is seen nearly everywhere. The Post Office alone possesses sixty-two cables, embracing 1,060 miles.

In the manufacture of iron wire England stands pre-eminent. Messrs. Johnson, of Manchester, have led the way with their continuous "rolling" method.

Our moist climate, smoky atmosphere, winter fogs, and salt-sprayed land have proved a sad source of trouble in insulating our wires. Messrs. Clark, Varley, Andrews, and many others have battled against these difficulties in vain. Several improvements are now under trial, such as Cordeaux's, to facilitate cleaning, Fuller's, to increase resistance, and Messrs. Johnson and Phillips', who have struck

out quite a new line by inserting a section of oil in the path of the current. Indeed, we are always experimenting in this direction. The higher classed apparatus that is being introduced needs higher classed insulation. The difficulties of this country are not experienced elsewhere, and therefore our efforts to cure the evil are not appreciated. The form that is found perfect in America failed miserably in England, and those accepted on the Continent are not to be compared to those in use here, when erected under similar conditions.

It is, perhaps, in the sending department that the greatest changes have been made.

Varley's double-current system, working with polarized relays, has survived all others; but the keys used in working it, which at first were cumbrous, and therefore slow in action, have been revolutionised by Mr. Stroh, and by the Post Office electricians. Keys manipulated by hand cannot be made to send more than forty-five words per minute, whereas the limit of recorders far exceeds this. Moreover, the hand soon tires, and cannot maintain the speed. Indeed, the average rate of sending of the best operator does not exceed thirty words a-minute.

Alexander Bain, in 1843, proposed to replace hand-keying by automatic sending, and thus to attain much higher speed. But Bain was before his time; there was not business enough to fill a wire, hence the system remained in abeyance. It was taken up again by Wheatstone, in 1868, when the necessity for improved methods began to be evident. This system has been very extensively employed by the Post Office, and at the present moment there are over 170 instruments worked. Indeed, without its aid it would have been impossible to have coped with the enormous amount of news which the cheap tariff thrust on the Post Office wires. Wheatstone's apparatus has been entirely remodelled and improved by the Post Office electricians. Nothing but the original idea remains, and the machine now turned out by Mr. Stroh is one of the most perfect pieces of mechanism employed in any art.

The telephone bids fair some day to be of use in some branches of telegraphy, but its progress has been disappointingly small, and its employment has been checked by the outrageous terms demanded.

The changes and improvements that have been made in the sending apparatus have been accompanied by equal improvements in the speed of working in the receiving apparatus. The laws of induction on wires and in instruments, the causes of retardation in working on long lines and submarine cables, have been carefully studied by English electricians, and means have been devised to reduce or remove the deteriorating influences. The currents sent to produce signals are varied in their form, so as to roll into one another and to become indistinguishable. While on a short line it is possible to attain 1,000 words a minute, or more, the rate of working rapidly diminishes with distance, and between London and Dublin it was difficult to maintain more than seventy words a minute. Modes of compensating upon the line itself the currents sent by the Wheatstone transmitter, and of connecting up the coils so as to eliminate the effects of currents induced in them, have been successfully introduced by the Post Office electricians, so as to increase the rate of working on long lines very considerably; and very recently, relays of exquisite manufacture have been constructed which, inserted as translating relays or repeaters at intermediate points, have still further increased the rate of working on automatic circuits between London and Dublin fifty per cent. Indeed, while the question of increased telegraphic communication between Ireland and England was under consideration, this more rapid mode of working solved the question. It has in some instances increased the rate of working over 100 per cent.

Bain's original chemical recorder has been resuscitated, but its use is attended with disadvantages which have not led to its extended employment. It is in use in Dublin.

Bain's recorder has also been resuscitated in America. Mr. Little applied to it a condenser as a shunt to prevent the confusion or running together of signals, due to induction on the line when running at high speed. He called it "an overflow dam." Mr. Edison effected the same thing in a better way by using an adjustable electro-magnet as a shunt. Immense speed was attained by this means.

It will thus be seen that the distinguishing feature that has characterised the improvements made by the Post Office officials has been in the direction of fast-speed telegraphy; and it is not too much to say that they have more than quadrupled the working speed of wires.

The improvements made towards increasing the capacity of wires is wonderful.

There are now in England nearly 200 duplex circuits worked, and our ocean cables, by the aid of peculiar condensers, introduced by Muirhead and Taylor, are gradually being duplexed.

Quadruplex telegraphy was suggested by Bosscha and Stark, in 1855, and by Mr. Oliver Heaviside, in 1873. It was patented in this country by Mr. Stearns, in 1874. It was devised by Mr. Walby, a Post Office official in Dublin, also in 1873. It was, however, for the first time put into practical operation by Messrs. Edison and Gerritt Smith, in 1876, upon the lines of the Western Union Telegraph Company in America, where it is now applied to sixty circuits. It is now being introduced by the Post Office. It works perfectly on short lines, but it becomes troublesome on long lengths.

It is capable of considerable extension and variation. In America it works to distances exceeding 1,000 miles by means of relays or repeaters fixed about the centre of the circuit. Thus New York works to St. Louis with relays in at Pittsburg. At the present time West Hartlepool and Middlesborough are each working duplex to London—on separate wires to Leeds, but on the same wire to London.

Telephone currents are very minute currents following each other with great rapidity, and they can be superposed on ordinary working currents without interfering with their action on ordinary telegraphic apparatus. Mr. Cromwell Varley utilised this principle in 1870, by patenting what we may call *harmonic* telegraphy, but it remained for Mr. Elisha Gray, of Chicago, to work the system out practically. He utilises the wires employed for serving "way" or intermediate stations, by working them also harmonically between their terminal points, thus vastly increasing their capacity. This system is now under trial in America.

Other systems for increasing the capacity of wires have also been devised on the Continent. Thus Meyer (whose instrument was exhibited at the Vienna Exhibition of 1873, and is now in use on a small scale in France and Austria) sends four messages in the same direction apparently at the same time; but they are not sent simultaneously, the signals are divided and distributed so as to obtain the maximum carrying capacity of the wire, and therefore the practical gain is not great.

M. Baudot, whose apparatus is exhibited at the Paris Exhibition, sends five messages upon the Hughes apparatus in the same direction, but they also are not simultaneous, and though by utilising the intervals of time occupied by the type wheel in revolving and distributing the signals, he increases the capacity of the wire, the gain is not very evident. The instrument is very complicated, and its practical success questionable.

The French Government is also trying an automatic system of type printing, devised by M. Olsen, which is said to increase the capacity of the Hughes type printer 33 per cent.

Now of all these systems, the most valuable, successful, and practical, are the Wheatstone Automatic and the Quadruplex. The average speed attained on the Automatic, on an average circuit worked simplex, is 100 words per minute, which becomes 200 words per minute when worked duplex. The average speed attained on the Quadruplex is 120 words per minute. Hence, when duplexed, Automatic is more capacious than the Quadruplex, but the elasticity of the Quadruplex makes it a valuable help to the Automatic system, and when the two are combined (which has recently been done by the electricians of the Post Office) the advantages of both are secured. One side of the Quadruplex is worked automatically, and the other side by ordinary keying.

But it must be remembered that each system has its disadvantages—principally the employment of a more highly trained staff. The Automatic system involves previous preparation, and therefore preliminary delay. The complication and delicacy of both systems involve better-maintained lines, and their failure tends to much greater trouble. There is a distance within which each becomes disadvantageous and expensive, and where it is cheaper and better to erect extra wires.

Now these systems of fast-speed and multiplex telegraphy have grown up in England under the fostering care of the Post Office since the transfer of the telegraphs to the State, and therefore I contend that I am justified in saying that greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration.

Necessity drove the Americans to the introduction of quadruplex telegraphy, as it drove us to the employment of the automatic system. The increased business demanded increased capacity of wires. Automatic telegraphy in America was in the hands of opponents. All the skill of the Western Union Telegraph Company was devoted to the improvement of multiplex telegraphy, and the quadruplex is the result. Neither duplex nor quadruplex telegraphy were, however, invented in America. They were imported there, but in a very crude condition. The great practical skill and ingenuity of our cousins made them what they are—the most valuable adjuncts to telegraphy.

It will be observed that in the above enumeration England stands prominent as the home of the inventor. While she can boast of Wheatstone, Cooke, Bain, Thomson, Clark, Varley, Fuller, &c., and Europe can boast of Gintl, Siemens, Frischen, Meyer, &c., America has her Morse, Hughes, Stearns, Edison, and Gray.

In 1868 the Western Union Telegraph Company, feeling that their telegraphic system was not up to the requirements of the age, secured the valuable services of Mr. Cromwell Varley, who educated them up to the Europern standard of electrical knowledge, and they have certainly bettered their instruction.

America has freely adopted our system of pneumatic telegraphy. They have introduced our methods of testing. They have adopted Johnson's method of manufacturing iron wire. They have introduced on some lines automatic telegraphy, modified by Messrs. Little and Edison. They are trying our superior batteries.

Hence, while we have not been slow to avail ourselves of their advances, they have equally availed themselves of our progress.

Telegraphy is thus cosmopolitan. Whatever of value and advance is produced in one nation is adopted by all. Invention has not left the shores of England. The English Telegraph Department stands in the front rank. Foreign Governments freely avail themselves of our experience. Our models, our plans, and our manufactures are found in every clime.

It remains for me to say a few words as to the part played by the Post Office in fostering these advances. The system of news wires is unique in its kind. Forty-seven news circuits and twenty-two special wires are made up every day for the transmission of intelligence. News is transmitted direct from London to every town in the United Kingdom at which a daily paper is published.

This is maintained by the automatic system. Half a million words are frequently sent in one night from London alone. When Lord Beaconsfield gave his address in the House of Lords on the results of the Berlin Congress, 526,250 words were transmitted from T.S. the central station.

There is not a branch of the service that has not been improved. New batteries, new insulators, preserved poles, improved wires, the most perfect relays, and multiplex apparatus have all found their way into the Post Office service. In 1873, 15,535,780 messages were transmitted over 105,285 miles of wire, being an average of 147 messages per mile of wire, while in 1878, 22,171,783 were sent over 113,333 miles of wire, being an average of 200 messages per mile of wire. Of the 8,000 miles of additional wire which have been put up, more than one-half is for *private* wire purposes; therefore the message average is really even higher than that given. Indeed, only 4,000 miles of wire have been erected to transmit nearly 7,000,000 messages, or an increase of nearly 50 per cent. of work.

No one has ever been heard to complain of the Post Office in adopting improvements but perhaps some disappointed inventor. It must be remembered that improvement is invariably the result of inventive power combined with practical experience, well

tempered with theoretical knowledge. Practical inventions rarely emanate from without. The long list that I have enumerated is, without exception, composed of men who have possessed these qualifications; but the great majority of patents are taken out by those who do not possess them at all. They are the most troublesome men to deal with. They cannot be convinced of their errors, and their want of experience prevents them from seeing their failure; but of the numerous patents that are annually taken out, how many complaints are made by those who have not been fairly and properly treated? The following table gives a list of patents which have been taken out for improvements in telegraphy for each year since 1862.

IMPROVEMENTS IN TELGRAPHY.

YEAR.	1	2	3	4	TOTAL.
1862	29	9	7	6	51
1863	13	7	8	3	31
1864	24	3	3	3	33
1865	24	27	8	7	66
1866	25	13	7	9	54
1867	39	7	4	4	54
1868	31	5	6	7	49
1869	28	11	3	6	38 Average. ——$48\frac{4}{7}$
1870	26	5	4	4	39
1871	17	3	4	10	34
1872	50	5	3	4	62
1873	49	5	2	6	62
1874	50	13	2	2	67
1875	25	12	2	2	41
1876	35	25	3	3	66
1877	42	3	—	1	46 Average. ——$32\frac{1}{8}$

NOTE.—Column 1 contains the number of Patents which refer exclusively to land lines.

Column 2 those which refer exclusively to submarine work.

Column 3 gives the Patents which refer to the manufacture of Telegraph material.

Column 4 gives those Patents which bear partially upon Telegraphy, and partly on other arrangements to which such inventions are also applicable.

They are thus now as numerous as ever, indeed, the average of the last eight years exceeds that of the previous eight; hence I am justified in saying that the possession of the telegraphs by the State has not checked improvement. Moreover, the telegraph system outside that of the Government is as great now as the whole telegraph system of the country was before the transfer, and inventors, if they are dissatisfied with the Government, have the numerous cable companies and the great railway systems of this country to fall back upon. Private enterprise is not dead.

The fact remains that telegraphy, whether for commercial or railway purposes, is more highly developed in England than in any other country, not excepting America, and this development is due as much to the action of the State in purchasing and managing the commercial system of the country as to the competition that remains between nation and nation and between company and company. The lines of the Post Office are now worked with a view to a fair commercial profit as much as any private concern. The action of the Governments in all departments is jealously watched by its master, the public. The master is not always just, nor generous. Its prerogative is to find fault with the Government in all that it does, and it is well that this right be exercised, for it forms a very valuable check on abuse, it strengthens discipline, and it secures a worthy discharge of duty.

I can speak from the experience of a commercial and of a Governmental department extending over twenty-five years, and I have no hesitation whatever in asserting that there is as much zeal, energy, and enterprise in the one as there is in the other. The control of Parliament and of the Press exercises a far more disciplinary and supervising power on the management of a Government Department than any half-yearly meeting of shareholders or occasional committee of investigation.

[One or two important papers read before the British Association we are compelled to leave over until the next issue.]

NEW APPLICATIONS OF THE MICROPHONE.

I. *The microphone in experiments.*—Step by step the telephone has become useful, not only as a practical tool, but as an experimental apparatus; and we are now able to record a similar advancement of the microphone. It is interesting to learn that Mr. Chandler Roberts, F.R.S., has successfully employed it in rendering the diffusion of the molecules of gases through a porous septum or partition, plainly audible. A more important application of it, however, has recently been made by Professor Hughes himself. He has just used it to settle, in a conclusive manner, the controversy which has been actively going on of late between Colonel Navez, of Belgium, and the Count du Moncel, respecting the true explanation of the physical action of the articulating telephone. It will be remembered that Professor Bell, in his address to the Society of Telegraph Engineers on the telephone last year, threw out the suggestion that the sounds given out by the telephone were due as much to molecular as to mechanical vibrations of the diaphragm. He was led to this conclusion by the fact that iron diaphragms so thick that they could not bend bodily under the varying magnetic attraction of the magnet of the telephone, were found to give out articulate sounds. The subsequent discoveries of Mr. Blyth and others, that diaphragms, not of iron, but of copper, pasteboard, glass, &c., also yielded such sounds, came with some surprise on the world, and also pointed to a defect in the existing theory of the telephone and the production of sounds, which explained the telephonic utterance by the wavering attraction of the magnet on the slim diaphragm which was free to vibrate to and fro mechanically like a drum head. M. du Moncel, in considering these facts along with the discovery of Page, Wertheim, and others, that an iron core gave out sounds when an intermittent current was sent through a coil of wire surrounding it, conceived the theory that it was in the core that the secret of the articulation of the telephone resided, and that the diaphragm merely intensified the latter so as to raise it to the range of our hearing. According to him the articulation was due to molecular vibrations set up in the core of the receiving magnet by

the waves of current passing through the coil, and that the diaphragm acted as an armature and concentrated the effect. M. Navez, in a communication to the Royal Academy of Belgium, took up arms against M. du Moncel's theory, and after first doubting that the core could utter sounds at all, afterwards admitted that under exceptional conditions the sound of the voice could be given out by a receiving telephone without a diaphragm, but that it was so weak as to render it impossible to decide whether there was articulation or not. This admission of Colonel Navez, while leaving himself a loop-hole of escape, at the same time surrendered one of the outposts of his position to M. du Moncel, who only contended that the articulate sounds were there but not sufficiently loud to be heard. One charge more remained for M. du Moncel in order to claim the victory, and this was to magnify these inarticulate sounds in the core to the degree of audibility. This has been achieved for him by Professor Hughes with the help of the microphone. Professor Hughes' experiments are as follows :—

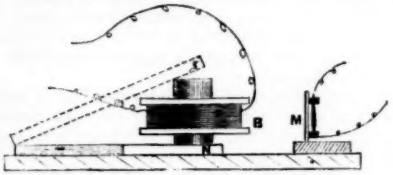


Fig. 1.

1. A bobbin of wire B (fig. 1), surrounding a soft iron core, is connected in circuit with a microphone and three cells. The ticking of a watch and other tones can be very feebly heard on listening to this simple electro-magnet. The sounds are very weak unaided; but on placing the electro-magnet on a wooden stand, to which is affixed an independent microphone circuit M, they are amplified by the latter, and can be distinctly heard in the microphone telephone. Here we have the microphone operating as a means of physical investigation. The vibrations of the core, due to the undulatory current traversing the coil, are brought into distinct audition through the medium of a microphone circuit.

2. These tones are in a striking manner intensified by bringing the pole of a bar magnet N into contact with one end of the core. *Articulation can now be distinguished* in the telephone of the auxiliary microphone, and the problem discussed by MM. Navez and Du Moncel may be regarded as fully solved, since the auxiliary microphone can only take up and intensify articulate vibrations first given out by the magnetic core of the bobbin, and communicated by the wood of the stand to the microphone. Here, then, we have the microphone rendering it possible for M. Navez to hear the voice proceeding from the core of a telephone without a diaphragm, and deciding that there is articulation.

3. When another bar magnet is placed with its opposite pole S in contact with the other end of the core (as shown by dotted lines in the figure), the effect is still further intensified. Here the core may be supposed to act as an armature concentrating the lines of magnetic force in the neighbourhood of the coil.

4. The two poles of a horseshoe magnet inserted together into the heart of the bobbin, instead of the magnetised core as figured, gave a strong effect also, notwithstanding the fact that one pole might be supposed beforehand to neutralise the other. This has also been observed by Mr. W. J. Millar of Glasgow. But the most distinct and loudest effect of all was obtained by placing a soft iron armature across the poles of this horseshoe magnet when inserted in the bobbin. Songs and articulation are well defined by this arrangement.

The striking increase in the loudness of the sounds given out by the core, in the first experiment, when the pole of the magnet was brought into contact with it, leads us to wonder whether the feeble sounds given out by the soft iron core itself were not due to some residual magnetism in it; and to doubt if a purely non-magnetic piece of iron would act at all. It is certain, at any rate, that an increase of magnetism in the core of a telephone intensifies its power of vibrating under the action of vocal currents.

II. *The microphone relaying itself.*—It is now well known that the "hammer and anvil" form of micro-

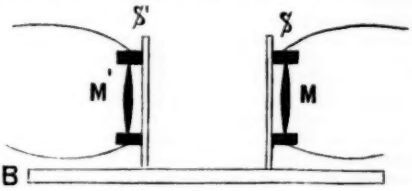


Fig. 2.

phone, when mounted upon a vibrating membrane or drum-head, is heard to act as a receiver of sounds, and to utter even articulate speech. To construct a successful one for this purpose, it is necessary that the hammer should weigh with a certain pressure on the anvil. Professor Hughes accounts for its action on the supposition that the alternate swelling and shrinking of the microphone contact, due to molecular causes as the vocal current passes, is unable to tilt up the hammer from the anvil because of its weight; and consequently the diaphragm beneath yields to the reaction and starts into vibration. Were it easier for the molecular forces to tilt the hammer than to bend the membrane, the vibrations would not become audible.

The microphone has, ere this, been successfully applied to relay telephone sounds; but Professor Hughes finds it to answer equally well as a relay for another microphone. Fig. 2 shows two microphones M M', mounted on upright boards S S', let into a base-board B. If M be connected in circuit with a transmitting microphone at a distance, and M' be connected in circuit with a battery and telephone, the sounds received by M from the distant microphone are relayed by M', and heard very distinctly in the telephone. For the telephone a receiving "hammer and anvil" microphone may be substituted, and then we have two purely microphonic circuits, one relaying the other, the sound, being transmitted by a distant pencil microphone relayed by a local pencil microphone, and heard proceeding from a local speaking microphone, no telephone being employed.

SOME ELECTRICAL EXPERIMENTS WITH CRYSTALLINE SELENIUM.

By ROBERT SABINE.

(*Concluded from page* 331.)

Action of Light and Heat the same.—The next experiment was to ascertain if the effect of light upon the surface is the same or the reverse of that of heat. Two short lengths of glass tube, fixed vertically, were stopped at the lower ends with corks, through which strips of platinum foil were passed. Across the tops of the vertical tubes (which were nearly filled with distilled water) two smaller horizontal glass tubes were fixed, over each of which a small saddle of white blotting-paper, intended to act as a conducting pad, was laid. The ends of the blotting-paper dipped into the water, and formed the connexion with a plate of crystalline selenium, whose ends rested on the paper on the horizontal tubes. The circuit was completed by inserting a galvanometer between the strips of platinum foil. The whole was mounted in a light tight case with a diaphragm, so that light could be excluded from or admitted to either horizontal tube at pleasure. When light was admitted to one tube, it had of course to reach the contact service of the selenium, after passing through the glass, the water, and the blotting-paper pad. It was, therefore, diffused and much weaker than had it fallen directly upon the face of the selenium as in the previous experiments. The indications were therefore less in amount, but nevertheless perfectly distinct.

Next, instead of admitting light to the selenium plate, both of the tubes were kept dark, and warm water was passed through either of the horizontal tubes, so that the wet blotting-paper pad upon it, and, therefore, the contact face of the selenium and water, was slightly warmed. A current was immediately observed. When this current had subsided, warm water was passed through the other tube, and the new deflection noted.

Now in both these tests it is evident that we are dealing, in respect of light and heat, with the *surface* of the selenium only, and have therefore eliminated any effects due to the molecular condition of the interior.

The following are the results :—

	End c.	End c'.	Deflection.
(1)	illuminated	dark	—200 div.
(2)	warmed	cold	—160 „
(3)	copper	zinc	—off scale
(4)	dark	illuminated	+ 50 div.
(5)	cold	warmed	+ 80 „

Therefore the effects of light and heat upon the surface of crystalline selenium are identical; and it was observed that this effect was to render the contact surface between crystalline selenium and water more electro negative.

Effect of Light on Conductivity.—The object of the following experiment was to determine whether the effect of light upon a plate of selenium when in a galvanic circuit, in increasing the current, is due to a photo-electromotive force in the same direction as the battery current, or to a decrement of resistance.

Let the resistance between the wires of the selenium plate in the dark and of the galvanometer be r, the electromotive force of the measuring battery be E, and the observed current c. On admitting light the current increases to c', and one of two things must have happened. Either (1) the increment of current is due to a decrement (x) of resistance, in which case

$$c = \frac{E}{r} \text{ has changed to } c' = \frac{E}{r - x},$$

$$x = E\frac{c' - c}{c\,c'}; \quad \ldots\ldots \quad \text{(I.)}$$

or (2) the increment of current is due to a photo-electromotive force (y) in the selenium, in which case

$$c = \frac{E}{r} \text{ has changed to } c' = \frac{E + y}{r},$$

$$y = E\frac{c' - c}{c}. \quad \ldots\ldots \quad \text{(II.)}$$

With a single measurement it is, of course, impossible to discriminate between the two cases; but by a known augmentation of battery and of resistance, it is easy to find which supposition affords the better agreement.

On increasing E to 2E, and inserting a known resistance (r_1) as nearly equal to r as possible, the resulting current, when the selenium was in the dark, was c_1; and it increased to c_2 when subjected to the same source of light as before. The either

$$c_1 = \frac{2E}{r + r_1} \text{ changes to } c_2 = \frac{2E}{r + r_1 - x},$$

$$x = 2E\frac{c_2 - c_1}{c_2 c_1}; \quad \ldots\ldots \quad \text{(III.)}$$

or

$$c_1 \text{ changes to } c_2 = \frac{2E + y}{r + r_1}$$

$$y = 2E\frac{c_2 - c_1}{c_1}. \quad \ldots\ldots \quad \text{(IV.)}$$

It is plain that, if the values of x calculated by (I.) and (III.) agree better than those of y calculated by (II.) and (IV.), the change must be due to resistance.

The battery consisted of twelve similar Daniell's cells of large surface. They were connected with a commutator, by which, with a single movement, they could be connected up either in series or six and six parallel. In this way, by using the same elements in each measurement, the effect of any slight accidental difference in their electromotive forces would be, to a great extent, neutralised. No difference could be observed by the discharge of an accumulator; and therefore it was assumed they were in every respect equal. The currents were measured by means of a reflecting galvanometer.

A selenium plate with six elements in the dark gave a current $c = 0{\cdot}498$ microweber. When the battery was doubled and the constant resistance r_1 added, the current observed was $c_1 = 0{\cdot}508$ microweber.

Diffused daylight admitted to the selenium, with the six double surface elements the current increased to $c = 0{\cdot}860$ microweber; with the twelve elements in series and resistance r_1 the current was $c_2 = 0{\cdot}643$ microweber.

Putting E = 6·72 volts, the values of x and y, calculated from the above data, are as follows :—

x		y	
I.	III.	II.	IV.
5·68 meg.	5·56 meg.	4·89 volts.	3·57 volts.

Similar measurements were made with two other plates, which gave the following results :—

x		y	
I.	III.	II.	IV.
6·39 meg.	6·43 meg.	5·76 volt.	3·86 volt.
5·52 „	53.0 „	0·75 „	0·53 „

It appears from the above, that the agreement between the calculated values representing the change, on the supposition that it is due to a decrement of resistance, is much greater than that between the values calculated on the supposition that it is due to an electro motive force set up in the selenium in the same direction as the battery current.

It is evident for these experiments that selenium is, from its peculiar nature, a very unsuitable material for constant resistances.

In the light it would of course be utterly useless for measuring-purposes, whilst in the dark the apparent resistance of its junctions with the conducting wires changes, not only with the direction of the current, but likewise with its strength, and to some extent also with its duration.—*Philosophical Magazine.*

THE QUADRUPLEX SYSTEM IN ENGLAND.

THE quadruplex system of Messrs. Edison and Prescott was introduced into this country in September, 1877. It has, therefore, been on trial here for a year.

Fears were from the first entertained that our variable climate would greatly interfere with the working of the system, and, at the outset, a battery of 100 Fuller's Mercury-Bichromate Cells was used at each end of the wire; the supervisors being Mr. Gerritt Smith, the Assistant Electrician of the Western Union Company in London, and Mr. Hamilton, also of the electrical department of that company at the Liverpool end. When once fairly started, and in spite of variable and stormy autumnal weather, the operation proved eminently successful. Four distinct circuits were worked steadily on that wire for six or seven consecutive hours daily, and the number of ordinary messages per hour transmitted on the Quadruplex was at that time surprising. As many as 213 ordinary despatches were sent and received within the sixty minutes; a total said to exceed the highest number ever heretofore attained by American telegraphists in the native land of the system. This result appeared to astonish Messrs. G. Smith and Hamilton, who, not unnaturally, had believed the famed manipulation of their telegraphic compatriots to be entirely unapproachable.

The Quadruplex continued to behave satisfactorily after the return of the American electricians to the States, and may be said to have since then exceeded even the most sanguine expectations of its capabilities.

After having been in operation for some months to Liverpool, the apparatus was removed to Leeds, where a number of experiments have been made, and some improvements introduced that will materially enhance its value. The carrying power of the instrument, great as it is, can be increased about twenty-five per cent. by the Wheatstone Automatic Duplex System being used on the "double current" side of the apparatus. This has been effected between London and Leeds at a speed of fifty to sixty words per minute in each direction, without at all interfering with the ordinary duplex working on the "single current" side. Thus we may employ two independent and different systems, both duplexed, and transmitting between them a grand total of, say, 260 messages per hour, upon one wire two or three hundred miles long. By the introduction of this important English improvement, the capacity of the Quadruplex, as we have said, has been augmented, and, besides, it has demonstrated the economy in wires that will result from the extension of the system. For instance, if one "side" be used as a Duplex Wheatstone Automatic circuit from London to a large centre, such as Manchester, the other section may be worked independently as an ordinary Duplex circuit to, say, Carlisle, if a local line wire between Manchester and Carlisle be connected to the Quadruplex apparatus, which would act as a translator or repeater on the "single current" side. A London-Manchester length would thus be economised.

We believe that the Post Office have decided to extend the Quadruplex system immediately to several important telegraphic towns; in fact, the additional apparatus required for six or seven new sets are now nearly completed. Birmingham, Bristol, Southampton, Plymouth, and Jersey are spoken of as likely to receive the early benefit of these additional instruments.

RAPIEFF'S ELECTRIC LAMP.

IN the last number of the JOURNAL we gave a short description of M. Rapieff's new form of Electric Lamp. In actual practice the arrangement of the carbons is slightly different from that shown by the figure, one set of carbons being set vertically over the other set, and not horizontally as was indicated. Also M. Rapieff, instead of having the two sets of carbons lying in the same plane, prefers to have the plane of one set, to be at right angles to the other.

We are enabled, through the courtesy of M. Rapieff, to give some details of the method he adopts for effecting the subdivision of the light. Fig. A is the base of a lamp (inverted), showing the mechanism for enabling the object in view to be effected.

M is an electro-magnet, provided with an ordinary armature at the left hand poles; this armature is connected to the lever l_2. The upper of the right hand poles is hinged, and is connected to the lever l_1, which is itself connected to the upper set of carbons.

The armature connected to l_2 being light, is quickly attracted when the electro-magnet is excited, and when so attracted, in virtue of its being brought in close proximity to the left hand poles, it causes the magnetism of the right hand poles to be intensified; the upper (in the figure) of these poles is then drawn towards the lower one and being connected with the upper set of carbons, separates this set from the lower set, to the distance requisite to give the electric arc its necessary length. This dis-

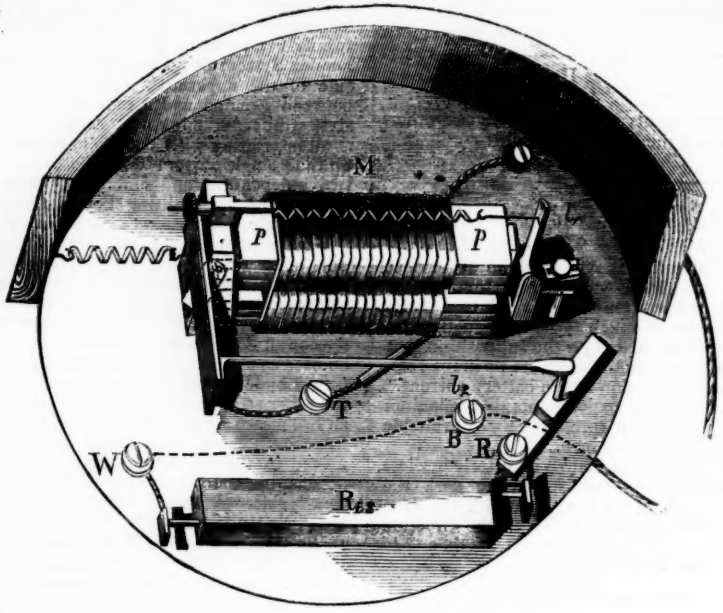
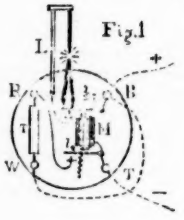
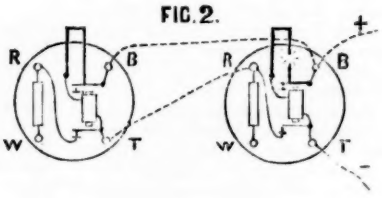
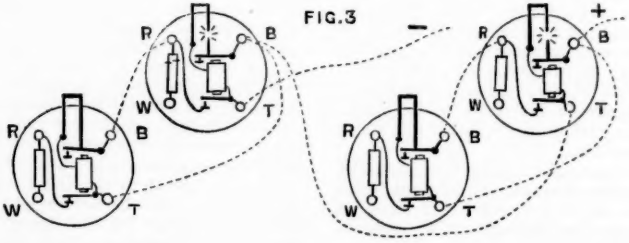


Fig. A.







tance can be adjusted to any width by means of set screws.

The lever l_2, when the armature attached to it is not attracted, makes contact with a contact point connected to terminal R. Between the latter terminal and terminal W, a resistance, rather higher than that of the electro-magnet (about 1 Siemens' unit), and made of pieces of carbon, is connected. The armature itself and the lever connected to it, are connected to terminal T, which terminal is also connected to one end of the wire of the electro-magnet. The further end of this wire is connected to the top set of carbons of the lamp, and finally, terminal B is connected to the bottom set of carbons.

Fig. 1 is an outline sketch, showing how a single lamp would be connected up for producing the light. In this sketch, l_2 is the armature and lever that break contact with terminal R; l_1 is the lever which separates the two sets of carbons. For the sake of distinctness in this and the following figures, this lever is represented as drawing down the lower set of carbons from the upper, though in practice, as was explained, it is the upper set of carbons that are moved.

The dotted lines represent the connecting wires necessary to work the lamp when it is used alone. Of these wires, those marked + and — are those leading from the machine.

The action of the apparatus is as follows:—

When the current is sent from the machine it enters, say, by terminal B, from thence goes to the lower set of carbons; and, as the two sets are normally in contact, goes to the upper set, through the electro-magnet, and back from terminal T to the machine. A portion of the current also traverses the resistance between terminals R and W.

Immediately the electro-magnet is excited, the armature connected to l_2 is attracted, and breaks the circuit of the resistance, so that the whole current passes between the carbons. The pole piece connected to the upper set of carbons is then attracted and separates the sets of carbons.

If there are other lamps connected in the circuit, and one of them should fail, from the carbons being consumed, or from any other cause, then the contact armature of the magnet of that lamp, by falling back, maintains the continuity of the circuit through the resistance.

Fig. 2 shows the connections when a reserve lamp is provided at each point where a light is being produced. Under ordinary conditions, that is, when the right-hand lamp is burning, the reserve lamp is cut out of circuit; should, however, the first-mentioned lamp fail, then the contact armature of its electro-magnet, by falling back, puts the reserve lamp in circuit.

Fig. 3 shows the arrangement of two lights with a reserve lamp to each.

THE ELECTRIC LIGHT.

Report by MR. G. H. STAYTON, C.E., to the Vestry of the Parish of Chelsea.

GENTLEMEN,—In accordance with your instructions, I have considered the question of the electric light in lieu of gas for street lighting, and have visited Paris to inspect the system now in operation in that city, with a view to reporting fully thereon.

I had interviews with M. Alphand, Director of Public Works (City Engineer); M. Jablochkoff, the inventor of the Electric Candle; M. Guichard, C.E., Agent to the General Electricity Company, and others, all of whom most readily afforded me valuable information upon the subject.

I learn that the Municipality of Paris have contracted with the above Company to light certain streets and places, notably the Avenue de l'Opéra and the Place de l'Opéra, which forms a magnificent new street nearly 900 yards in length and 30 yards wide. To effect this the Company have erected 46 lamp columns for the electric lights, at an average distance of 38 yards apart, on each side of the street, and have established three electric stations.

The lights consists of the "Jablochkoff Candle," utilised by means of the "Gramme" Dynamo-Electric Machine, by the aid of which 16 candles, (*i.e.*, lamps) are maintained, a steam engine being required to set and keep it in motion.

An electric machine is provided for every 16 lamps, the engine being placed in one instance in the front basement of an unfinished building, in another in a back room on the ground floor of similar premises, and in a third in the basement of the Opera House.

The electric apparatus is worked by a 16 h.-p. steam engine, with shaft and belts (1 h.-p. per lamp being thus absorbed), from which conducting wires for the current are laid in drain pipes under the footways, and carried to the lamps.

Upon a stand fixed on the top of the lamp-posts, at a height of about 16 feet, opaque globes (*Verre Opale*) about 18 inches diameter, are fixed, and they contain what is called the "Chandelier," which receives the candles.

An electric candle costs 7½d., and burns one hour and a half, but the chandeliers are made to receive in advance any given number of candles, and by means of a simple self-acting arrangement, when a candle is nearly consumed, the current is passed to a new candle, and the continuance of the light is assured without any visible interruption.

The intensity of a single electric light is stated to be equal to 700 wax candles, but the globes take off about one-third of the light. An ordinary street gas-light in London being equal to 12 or 15 candles, the superiority of the electric light may be easily understood.

The contract referred to may be termed an experimental one to a certain extent. The Company undertook to light the lamps for a period of six months, ending in November next, from dusk till shortly after midnight, and to provide the whole of the apparatus for 1f. 45c. (1s. 2½d.) per light per hour. Shortly before the electric light is extinguished, about one-third of the gas lamps are lighted and continue till sunrise, the former light being unnecessarily powerful, and too expensive to be maintained all night.

The number of lamps provided for lighting the Avenue and Place de l'Opéra by gas is exceptionally great; I should estimate that there are no less than 400 lights. The columns are placed at very short intervals, and have either three or five lamps thereon, consequently the average distance between each light if placed in a line, would be about five yards only.

Although such ample provision is made for gas,

the City Engineer says "that the cost of the Electric Light is four times that of gas, but a greater amount of light is obtained." On the other hand, in the lighting of the courtyard of the Louvre, it is asserted that a saving of 29 2-3 per cent. is effected by replacing 201 gas lamps by 16 electric lights, although 3½ times the amount of light is given.

It is scarcely necessary to remark that the leading thoroughfares in Paris are exceedingly well lighted. There are altogether 39,000 lamps in the city, the annual cost per lamp being £5 16s. Gas is supplied to the Municipality at *one-half* the price charged to private consumers.

The electric light has also been adopted for lighting the Place du Théâtre Française, the Madeline, the Arc de Triomphe, the Orangerie des Tuilleries, the Magasins du Louvre, and about thirteen other places in Paris. It is also in operation in the principal places in Brussels, Madrid, and St. Petersburg.

COST OF ADOPTION.—The distance between the lamps in Chelsea being much greater than in Paris, and there being only one lamp upon each column, greatly increases the comparative cost of the systems. They are somewhat irregularly placed, but the distance apart on each side averages about: 55 yards in Sloane Street, 70 yards in King's Road, 35 yards in Lowndes Square, 35 yards in Cadogan Place, 28 yards on the Chelsea Embankment. In Piccadilly the distance is 30 yards, and in Cromwell Road, South Kensington, 27 yards.

To adopt the electric light for Sloane Street, which is 1,100 yards long and 20 yards wide, would necessitate two electric stations, each of which would require a 16 h.-p. steam engine, including shafts, belts, &c., a "Gramme" dynamo-electric machine, a shelter or other building for the machinery and apparatus, the alteration of 16 lamp columns, together with globes, stands, connectors, and the necessary conducting wires, the total expense of which would amount to the sum of £3,200.

The cost of lighting 32 electric candles, including coal, oil, waste, wages, &c., *per hour* would be 16s., and 3,250 hours consumption per annum would be required unless the lights were extinguished and gas substituted at midnight, as in Paris, in which case the annual cost would not be so great.

The present cost of a gas lamp in Chelsea burning 3,850 hours per annum is £3 6s. 7d., therefore the expense of the 40 lamps in Sloane Street is 8¼d. per hour.

To light the Chelsea Embankment, which is about 1,530 yards long, and has 109 gas lamps (including those on the river wall belonging to the Metropolitan Board of Works), would require a first outlay of £4,800 for 48 lights of 3,250 hours per annum, with an hourly cost of £1 4s. The present cost of the gas lamps is 2s. 1½d. per hour for 3,850 hours per annum.

To adopt the system in Sloane Square (where there are but 17 lamps) would scarcely be practicable, even if the motive power could be obtained from the pumping engine of the Metropolitan District Railway Station, or from the engine of any manufactory in the locality after the close of the ordinary day's work.

In connection with the foregoing estimates, it must be remembered that in the case of Sloane Street, the amount of light would be 31 times greater than at present, which might be considered an unnecessary expenditure; but the electric current is said to lose 40 per cent. of power beyond a radius of about 250 yards, consequently a "Station" for 16 lights has to be established at about every 500 yards which greatly increases the expense. Probably half the above number of electric lights would be found sufficient for effectually lighting Sloane Street, if the quality of the current could be fully maintained at double the distance, by which means alone the cost would be reduced 50 per cent.

GENERAL CONCLUSIONS.—I have arrived at the following conclusions, which may be thus stated briefly, viz. :—That the present arrangements for electric lighting are unsuitable for long distances (in this I am supported by the City Engineer of Paris), especially in London, where the lamps are so much farther apart than in Paris. The close proximity of the electric stations is a great drawback to the system, and their establishment in business streets would be a matter of considerable difficulty. These are the disadvantages of the system. The following are the advantages :—

About 1½ hours' daily consumption is saved in consequence of instantaneous lighting and extinguishing; the light is vastly superior to gas, and is not injurious; there is an absence of noxious smells both in the production and combustion; the heat in a room, so often unbearable in the case of gas, is scarcely felt; the most delicate colours are preserved; air is not consumed as in the case of gas; there is no chance whatever of explosion, and, although the light is so powerful in the streets no accidents to horses have occurred.

If the cost of producing the "Gramme" machine (10,000f.) could be reduced, or a less expensive one be adopted; if hydraulic, or some other less expensive power, such as a petroleum engine, could be utilised as the motor in lieu of steam, or even a smaller amount of power than one-horse per lamp be rendered sufficient; if the distance between the electric stations could be greatly increased, the arrangements made capable of minute subdivision, and by some simple method the current could be branched off for household or other requirements, I feel sure that the public would gladly welcome such a change, and it would compete with gas under highly advantageous conditions.

The question is now largely occupying the attention of scientific men. At a recent meeting of the Institution of Civil Engineers, its discussion occupied three evenings. One speaker asserted "that one of the greatest advantages he saw in its introduction, was the possibility of its adding to the hygienic properties of buildings, as fresh air could be preserved, because the electric light consumes none, whereas gas consumes an enormous quantity." Another speaker (Sir William Thomson) having made a suggestion as to the construction of a copper tube for producing the electric light at a great distance, said "that he believed it would be possible to carry the electric energy to a distance of several hundred miles. The theory appeared to be that towns henceforth would be lighted by coal burned at the pit's mouth, for which purpose the dross could be used." On the other hand, another speaker asserted "that in all probability, *before* the electric light was perfected, the cost of manufacture of gas would have been so far reduced as to lift it even further beyond the reach of competition, and that

gas-makers' future promises in regard to improvements were as bright as those of the promoters of the electric light."

After a careful consideration of the whole question, I am of opinion that at present the electric light is *not* suitable for street lighting in the metropolis; that it *is* suitable and can be utilised with splendid effect in large squares and places, such as Trafalgar Square or Parliament Square; but although in each of these places at the present time the lamps are numerous, the cost would be greater than gas.

I am also of opinion that so soon as the modifications alluded to can be effected (particularly as to the electric current being carried to a much greater distance, thereby reducing the cost), the electric light will very soon supersede gas to a considerable extent, the attendant advantages being so great.

The following letter by Mr. J. Hollingshead has appeared in the *Globe*.

To the Editor of the GLOBE.

Seeing that Mr. G. H. Stayton's report on the electric light (I presume the "Jablochkoff Light") of Paris is going the round of the papers, I have referred its statements to Mr. Mayer and the French scientific gentlemen whom I brought over from Paris to establish and manage the electric light (called the Lontin Light) which I am burning every night in the Strand. Their answer, supported by elaborate details, is this:—"With machinery valued at £3,400 they are prepared to light an area of 1,540 yards long by 44 yards wide, with 36 electric lamps, exactly similar to those we are now using, having all the admitted advantages of the electric light, and an illuminating power equal to 2,000 of our existing street lamps, at a cost of 10s. 6d. per hour for consumption and superintendence. Thus, in place of 109 gas lamps, the public would get a lighting power nearly twenty times greater at a cost only five times greater than the present outlay. By reducing the number of lamps and making other alterations, the illuminating power and the cost could be reduced at the same time, until the difference between the cost of gas and electricity would be equalised, still leaving immense advantages on the side of electricity."

Yours, &c.,
JOHN HOLLINGSHEAD.

14, Pall Mall,
August 19th, 1878.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In Mr. Fahie's paper "On a New System of Duplex Telegraphy" (TELEGRAPHIC JOURNAL, April 15, 1877) there are some errors and mis-statements which I think you would like to be brought to your notice.

Mr. Fahie remarks that when

$$\frac{A}{B} = \frac{E}{L + X + E},$$

and

$$\frac{A'}{B'} = \frac{E'}{L + Y + E}$$

R is not affected by working K, nor R' by working K'. Substituting the values of the letters in the example given by Mr. Fahie, we have—

$$E = E' = 100$$
$$L = 3050$$
$$X = Y = \frac{600 \times 1500}{600 + 1500}$$
$$= 428{\cdot}5$$

Hence

$$\frac{A}{B} = \frac{A'}{B'} = \frac{100}{3050 + 428{\cdot}5 + 100}$$
$$= \frac{100}{3578{\cdot}5}$$
$$= \frac{33{\cdot}3}{1192{\cdot}8}$$

But in the example $\frac{A}{B} = \frac{A'}{B'} = \frac{39}{1461}$.

Mr. Fahie says that when K is depressed "the greater part of the current from E goes to earth * * * and only the equivalent of 8·3 cells goes out to the line, or (say) $\frac{1}{4{\cdot}8}$ of the original strength, 40 cells."

The greater part of the current goes through the "up station" apparatus, and not to earth, and the remainder *through earth* to "down station" and line. The latter = 5·1 cells, not 8·3 cells

The current in the line is therefore = 45·1 cells, and the relay R' is actuated by 32·2 cells.

The following sentence is incorrect. "A signal, therefore, begins to be recorded, and its strength is the difference between 57 and 34·5 cells, or 22·5 cells." The strength of the signal = 34·5 (32·2) cells, not 22·5 cells, and the difference between it and the former signal = 22·5 (24·8) cells. It is obvious that the above sentence does not convey Mr. Fahie's meaning, as further on he observes: "a like effect is produced by working K', R' is unaffected, while the current in R is reduced by 22·5 cells."

In the sequel, Mr. Fahie tells us "according, then, to the positions of the keys the line is traversed by currents of the following strengths—80 cells when both levers are at rest, 48·3 cells when one up and the other down, and 16·6 cells when both down."

What we particularly want to know is the effect which the currents produce on the relays and why duplex work is possible. This would have been more clear if Mr. Fahie had shown that—

(1) When both keys are at rest, current through each relay = 57 cells.

(2) When one key is depressed, current through relay of that station = 53·5 cells; current through relay of other station = 32·2 cells.

(3) When both keys are depressed, current through each relay = 28·5 cells.

The above are the results of my calculations with which I need not trouble you.

Mr. Fahie gives a formula for finding the proper value of the shunts.

$$A + B = \sqrt{RW}$$
$$= \sqrt{600\,(3050 + 600 + 100)}$$
$$A + B = \sqrt{600 \times 3750}$$
$$= \sqrt{2{,}250{,}000}$$
$$= 1500$$

which is correct.

On page 87, however, there is a misprint—

$$B = \frac{L + X + E}{L + X + E' - E}\sqrt{R\,W}$$

should be

$$B = \frac{L + X + E'}{L + X + E' + E}\sqrt{R\,W}$$

I should be pleased to get an explanation of the discrepancy pointed out at first; viz, why $\frac{A}{B} = \frac{33'3}{1192'8}$ instead of $\frac{39}{1461}$.

I am, Sir,
Yours truly,
H. A. W. FANSHAWE.
Indian Gov. Telegraphs.

ELECTRICITY IS LIGHT.

To the Editor of THE TELEGRAPHIC JOURNAL.

Sir,—Can it be possible that what has all along been called electricity is nothing else but light, and that it is light and nothing but light that is, at the present moment, crossing and recrossing the innumerable wires from one world's end to the other? Why should light, in a condensed form, not travel better in silver, or iron, or copper, than it does in the firmament? Why should it not travel worse in gutta-percha or glass? What is lightning? Is it not a discharge of condensed light? Why should the earth not attract light to its centre the same as it does an apple falling from a tree? If it does do so, would this not account for the perpetual furnace that is blazing below our feet? Can light not be positive and negative? Is it not indestructible? If it be indestructible would not a discharge take place when that great condenser, the earth, is too full of it? Is it not reasonable to suppose that this discharge would be enormous, and that it would take place in the Poles? Is the "Aurora Borealis" not the positive discharge? Is the "Aurora Australis" not the negative? Would such a discharge not enter and disturb all light conducting wires within a radius of many a mile? Does this not happen? What is a battery? Is it not an arrangement for accumulating light? What is a microphone? Is it not an arrangement for varying the intensity of this light during its passage through a light conducting substance? Will not all this unravel the mystery of the loadstone and many other mysteries?

I hope your readers will not make light of this subject; but if they can throw any more on it, or, if they can completely extinguish it, they will oblige me by doing so through the medium of your esteemed JOURNAL.

F. VON DER PFORDTEN.
Superintendent,
The Eastern Extension Telegraph Co.
Foreign Memb. Soc. Tele. Engineers.
Batavia, Java.
24th July, 1878.

H. A. W. F.—The telegraphic arrangements in Cyprus are, we believe, at present in charge of a detachment of the Royal Engineers, but for further information on the subject we would recommend you to apply to the Secretary of State for the War Department.

Notes.

THE TELEPHONE.—M. Righi, a professor of Boulogne, has constructed a transmitting telephone, which appears to combine those of Edison and Gray. In Gray's telephone, it will be remembered, a needle sticking out rom a diaphragm probes into a liquid conductor under he vibrations of the voice, and regulates the current in this way. In Righi's form the liquid is replaced by a mixture of plumbago and silver powder, and a small brass disc is substituted for the needle. The current from two Bunsen cells is employed; the receiver is a Bell telephone with parchment membrane. With this combination the sounds can be heard at a distance of several metres from the receiver.

THE first use of the telephone under water in this country (America) has been recently made in connection with submarine examinations in Boston Harbour. The character of these examinations was such that it would have been impracticable to undertake them without its aid, as almost constant communication was necessary between the diver and his assistant in the boat. The telephone used under water has a metallic case so modified in form as to occupy but little space, and is attached by screws to the inside of the diver's helmet in such a position that either the ear or the mouth can be applied to it. In the boat a single telephone of the ordinary form is used. The insulated copper wire connecting the two telephones passes through the air pump box. Between the pump and the diver's helmet it is wound spirally round the air hose, the wire and hose being then tightly wound around with canvas, for protection against injury. At first two connecting wires were used, the second not necessarily insulated, but it has since been found better to substitute for the second wire a shorter wire connecting the upper telephone with a copper plate fastened under the boat.—*Engineering News*, U.S.

THE TELEPHONE AND TORPEDOES.—A very ingenious and interesting application of the electric telephone to torpedoes has recently been effected by Captain C. A. McEvoy, U.S., of 18, Adam Street, Adelphi. This gentleman, who is well known as an authority on torpedoes, has utilised Professor Bell's articulating telephone for the purpose of testing buoyant contact torpedoes, large numbers of which have been provided by nearly all maritime governments for the defence of their rivers and harbours in the event of war. Torpedoes of this class have a certain amount of buoyancy, and are held in their places under the surface of the water by means of mooring lines and anchors. They are connected with the shore by electric cables, through which they are tested or exploded from the batteries on land. They may also be exploded electrically when struck by passing vessels, which result is accomplished by means of a delicate piece of mechanism known as a circuit-closer, which, with the fuse and the explosive charge, is contained within the torpedo. After the torpedoes have been moored, it is necessary that they should be constantly tested, in order to ascertain their condition, to know—that is, that they are still afloat and their charge not drowned. The testing is performed by sending a current of electricity through the torpedo and fuse; but in order that the fuse may not be fired, and the charge exploded during testing, a very weak current only is employed in connection with a

sensitive galvanometer. The result of this testing is that the delicate indications received are frequently of a most unreliable character, and difficult to determine from those of occasional leakage in cables and their connections. Captain McEvoy, therefore, substitutes testing by sound for electric testing, or at least to supplement the latter by the former. To do this he places in each submerged torpedo an ordinary Bell telephone, so arranged that the vibrating disc lies in a horizontal plane. On this disc he arranges a number of small moveable weights which are enclosed. These little weights, with every motion of the torpedo, cause a vibration of the disc, and a peculiar noise is heard in the receiving telephone on shore. By this means each torpedo tells its own tale, as regards its condition, to the operator on land. Should any of the torpedoes from any cause be sunk, or should their charge be drowned, they would be at rest on the bottom, or earth would be made: in either case no sound would be heard, and this would afford unmistakable evidence of the unsatisfactory condition of such torpedoes as were silent. The telephones are connected to the ordinary wires or cables of the torpedoes, and they in no way interfere with testing by the electrical method. One telephone on the shore will suffice for testing any number of moored torpedoes. From what we have stated, it will be seen that Captain McEvoy has started an idea which may probably form the basis of a far more simple and reliable system of defensive torpedoes than we now have, and which may, moreover, be applied to other useful purposes. Captain McEvoy has experimented with Professor Hughes's microphone in connection with the present subject, but he does not find it so well adapted for his purpose as the telephone. This arises from the extreme sensitiveness of the microphone and the delicacy of its adjustment, a feature which renders it more liable to error when placed in positions where it cannot be got at for occasional readjustment. The telephone would seem to be the instrument for the work, and we congratulate Captain McEvoy on this happy application.—*Engineering*.

DR. HENRY MORTON, of the Steven's Institute of Technology, Hoboken, New Jersey, U. S., obtains very loud musical sounds by means of a simple Reiss telephone, in circuit with a horse-shoe Bell telephone, the diaphragm of the latter consisting of an oblong plate of soft iron glued to the bridge of a guitar, from which the strings have been removed. This armature is attracted by the vibratory current and the guitar reinforces the sound so that its singing can be clearly heard in a hall containing 3,000 persons.

MR. F. G. LLOYD, Highgate, writes to the *English Mechanic* for August 9th, describing several experiments by which he has been able to receive articulate sounds, both speaking and singing, on a telephone without any diaphragm, that is, on a simple electro-magnet. The transmitter was a microphone, and four Leclanché cells were in circuit. The same electro-magnetic arrangement also proved a feeble transmitter, a Bell telephone being used as receiver. This curious fact supports the theory of the telephone espoused by M. du Moncel.

THE MICROPHONE.—A naturalist, Mr. Bairstow, suggests the use of the microphone for the investigation of the stridulation of insects.

THE London Stereoscopic Company are making an extremely useful practical microphone; not a toy, but a powerful speaking telephone.

MR. CHANDLER ROBERTS, F.R.S., has made an interesting application of the microphone to the phenomenon of the diffusion of gases. By its means he is enabled to hear the pattering of the atom shower of gases diffusing through a porous septum. The noise is said, without exaggeration, to resemble the rush of a tropical rain-squall through a forest. It must be very gratifying to Professor Tyndall to know that he may yet listen to the clash of atoms and the *melée* of molecules.

THE PHONOGRAPH.—In his study of the phonograph record, Mr. Edison finds that he can recognize certain known sounds from their indentations when these sounds are made by the same person, not unless. In spite of the irregularity existing in the points of the same sounds uttered by different persons, or by the same persons under different conditions, he claims that the record of any one sound can be distinguished from any other sound. Between the records of vowel sounds very little difference could be detected. For some vowels the indentations were deeper at one end than at the other; giving to the characters the shape of eggs, pears, and Indian clubs. This is usually the case with the vowel E. The deepest indentations are made by consonant sounds—on account of the explosive force with which they are uttered; P, especially being distinguished by the pit which begins the imprint.

AN American paper informs us that the phonograph has now been so highly perfected and improved that one can smell whiskey when it speaks.

ALL the materials for constructing a cheap phonograph which will talk, whistle, and sing, are being sold in America for a dollar and a-half.

THE French papers state that Mr. Edison will not receive any award at the Paris Exhibition for the phonograph. This is because the jury of the section on Instruments of Precision declared it not to be an instrument of precision, but a toy; and the section on Telegraph Apparatus judged it to be of no use in telegraphy, and refused to examine it. Our neighbours, in their boasted passion for method, very frequently destroy all method. The phonograph is properly an acoustical instrument of precision—the researches of Messrs. Jenkin and Ewing on articulate sounds put this

beyond question; and it is also a telegraphic instrument, inasmuch as it can, and will, be used for audible signalling.

THE Vestry of St. James's have intimated that the Lane Fox system of lighting the street lamps by electricity recently tried at Pall Mall has not succeeded, and that the apparatus will be removed.

THE cable and caoutchouc factory of M. Mennier, Rue de Grenelle, Paris; the workshops of MM. Sauter and Lemonnier, Rue Suffren, are lit electrically eve ry night. At the spinning mill of Champ du Pin (Epinal). four electric lamps have been employed to light a flat of 1,314 square metres. Each lamp, with its clouded globe, yields a light equal to 80 carcel lamps with an expenditure of two horse-power. The workmen prefer it to gas.

THE Town Council of Ayr has resolved to carry out a series of experiments in lighting the town with electricity.

ON another page we print the report of Mr. G. H. Stayton, the surveyor of the Chelsea Vestry, on the new systems of electric lighting in Paris, and also a communication from Mr. Hollingshead on behalf of the Harding Electric Light Company, 14, Pall Mall, formed to work Lontin's system, which is to be seen nightly in front of the Gaiety Theatre, Strand.

A FURTHER amalgamation of the London Gas Companies is reported. There are now six companies in London. Of these, the Phœnix, which supplies half the gas consumed in South London, has agreed to amalgamate with the Chartered, which furnishes two-thirds of the supply for the whole Metropolis. Proposals for the union of the Chartered with the Surrey Consumers Company, and with the South Metropolitan Company have also been made. The sanction of the Board of Trade and the approval of the shareholders are required for these amalgamations, but no application to Parliament is necessary.

THE Metropolitan Board of Works has instructed its scientific staff to consider the whole question of electric *versus* gas lighting.

THE gas companies begin to show their dread of the rival light by taking it up themselves. The Chartered Gas Company are experimenting with it on their premises, and going into the question of cost and manipulation. This is prudent policy on their part; but it is to be hoped for the public benefit that they will not be able to effect a monopoly of the new lighting power.

WE understand that Dr. Ager has in the press a second edition of his Telegram Code, to appear shortly. The work has been greatly enlarged so as to afford facilities for sending about 50,000 telegrams. The Code words have been revised by a competent telegraphist, connected with a leading telegraph company.

General Science Columns.

WE are informed that a course of six lectures on Meteorology will be given under the auspices of the Council of the Meteorological Society, commencing in October next. The subjects of the lectures will be, "The Nature and Physical Properties of the Atmosphere;" "Air Temperature; its Distribution and Range;" Atmospheric Pressure, Wind and Storms;" "Clouds and Weather Signs;" Rain, Hail, and Electricity;" and "The Nature, Methods, and General Objects of Meteorology." It is intended that these lectures shall give a concise account of the present state of knowledge on the above subjects. The lectures will be open to the public, admission being by ticket, to be obtained at the office of the society, 30, Great George Street, Westminster, S.W. Further particulars giving full information as to the time, place, &c., will be duly announced.

THE YELLOWSTONE PARK.—Protect the Yellowstone Park by all means possible and practicable. It is a creation that no vandal should be suffered to gaze upon. Secretary Schurz's request for 15,000 dollars to improve and protect it should be granted without a dissenting voice. The report of the superintendent of the park shows the absolute necessity for a live guardian—one who can shoot. The superintendent says that the Act of March 18th, 1878, set aside and dedicated the Yellowstone National Park for the benefit and enjoyment of the people, and provided formally against trespassers, and for the preservation from injury and spoilation of all timber, mineral deposits, and natural curiosities and wonders within it, and their retention in their natural condition; also against the destruction of fish and game and for the construction of roads and bridges therein. No appropriation has as yet been made to execute this legislation within my personal knowledge, which is confirmed by official publications and those of travellers. Valuable forests of pine and cedar timber have been prostrated and travel impeded by the careless use of fire. Bison, elk, antelope, big-horn sheep, and other beautiful and valuable animals have been slaughtered by the thousands merely for their tongues and pelts. Great masses of ancient timber, fossils, geysers, cones, and beautifully scalloped pool borders which made the region valuable have been broken up to obtain transportable specimens, which have been made articles of fraudulent commerce. The preservation of these animals and wonders, and the construction of roads, bridges, &c., are necessary to carry out the Act. The opening of the great Yellowstone route by steamboats, and the approach of several railroad routes in rapid construction towards it, show the immediate need of practical means, both to preserve the park from irreparable damage, and to make the beauties enjoyable.—*Ex.*

COATING IRON WITH RUST.—A new process for coating iron with a protecting layer of oxide is announced from America. Mr. G. Bower places the articles to be coated in a chamber of fire-clay provided with two pipes—one for the admission and the other for the escape of air. Both pipes having been closed, the heat is raised to a temperature of about 1,700 degrees Fah. At the end of each hour the pipes are opened so that fresh air may enter and drive out the deoxidised air. This process is continued until a film of gray, or magnetic oxide, is formed on the articles.

PLATING IRON WITH PLATINUM.—M. Dode, of Paris, has patented a process for coating iron with platinum. The iron first receives a coating of lead and copper, and then the platinum is applied. The first coating is prepared by mixing 22 parts of borate of lead and 4½ parts of cupric oxide in oil of turpentine, and is applied by means of a fine brush. The platinum coating is prepared by converting 10 parts of platinum into chloride, which is mixed with 5 parts of ether, and permitted to evaporate in the air. The residuum is mixed with a viscid combination of 20 parts borate of lead, 11 parts red lead, and some oil of lavender, and 50 parts of amylic alcohol added to the whole. In this mixture the object to be platinised is dipped, allowed to dry in the air, and then heated to a moderate temperature.— *Journal of Applied Science.*

A SUBMERGED TORPEDO BOAT.—The Rev. G. W. Garrett, Manchester, has invented a torpedo-boat which is capable of sailing under water and fixing torpedoes to a ship's hull. It can be propelled by the men on board, by compressed air, or other motive power, and is lighted by electricity. Electric beams can also be directed in any direction under water. The supply of air taken in for the use of the men is purified by a very ingenious process, which is also applicable to diving bells, and enables the men to remain several hours submerged. A successful trial of this boat was made recently at the Birkenhead docks. While on this subject we may mention that a new and very devastating torpedo has been invented by Mr. Ericcson.

City Notes.

Old Broad Street, August 29th, 1878.

THE report of the Submarine Telegraph Company shows that the receipts for the six months ending 30th June last, amounted to £59,016, or a decrease of £886 compared with the corresponding period of 1877. The net profits are stated to be £38,875, and out of this it was proposed to declare a dividend at the rate of 17 per cent. per annum. The balance brought in from the last account was £359, and the balance now carried forward is £327. The half-yearly meeting of the proprietors was held on the 20th inst. at the City Terminus Hotel, Sir James Carmichael, Bart., in the chair. The report having been taken as read, the Chairman said: "The Directors had found it necessary to insert a new length of about five miles in the cable between Jersey and France, which cost £1,123, and this sum had been charged to the cost of repairs in cables." He then moved the adoption of the report, and attributed the decrease in the receipts to the depressed state of trade, and was glad to say that "since the half-year had terminated their business had returned to its former favourable state. The reserve fund now amounted to £64,000. He was pleased to see that in addition to the invention of the telephone, a new invention had been made by which taste could be conveyed along telegraphic wires, and the company would be very happy to lease one of their wires to the Lord Mayor and the Corporation of the City, by means of which they would be enabled to entertain municipal authorities of foreign countries at sumptuous banquets." (Laughter.) Mr. James M. Wood, a shareholder, having formally seconded the motion, a short discussion ensued, and, in reply, to questions and observations, the Chairman said they estimated the "life" of their steamer at about fourteen years. It would always be worth its money. The Secretary said they had already £3,622 to the credit of the steamer fund, and the French Company had another £1,200. This made together £4,822, and the steamer cost only £15,000. The Chairman further observed that the sum of £4,822 was independent of the boilers, for which they had a separate fund. They were, therefore, making provision sufficient for the steamer. He then put the motion, which was carried unanimously. The Chairman then moved the declaration of dividend for the half year at the rate of 17 per cent. per annum. Alderman Sir Thomas Dakin seconded the motion, which was carried unanimously. The Hon. Ashley Ponsonby, a Director, then moved the re-election, as members of the Board, of Sir James Carmichael, Bart., and Sir Julian Goldsmid, Bart., M.P. The motion was seconded and carried unanimously, the retiring auditors having also been reappointed.

The ordinary general meeting of the shareholders in the Mediterranean Extension Telegraph Company was held on the 21st inst. at the City Terminus Hotel, Cannon Street. Sir James Carmichael, Bart., was in the chair.—The report stated that the half year showed a sensible improvement over the working of the previous one, and but for the troubled condition of Greece, which had interfered with the Corfu traffic, would have exhibited a still better result. There had been a suspension of work for some time past through the Alga-Grande cable. The Board recommended payment of the usual 8 per cent. dividend on the preference shares, less income tax, and of 3 per cent. on the ordinary stock, free of income tax, leaving £471 13s. 4d. to be carried to the reserve fund.—The Chairman in moving the adoption of the report and accounts, observed that he did not know that he had many comments to make on the report. As to the cable which was injured, it was the old cable; the injured part was about seventeen or eighteen miles from the Sicilian coast. There was no difficulty in repairing it, but the steamer belonging to the Eastern Company had had a good deal of work to do for the Government, and they had been unable to allow the use of a steamer. Meantime the work was done by the other cable, so that the injury only led to delay. When they could get a steamer probably it would only take a short time to do the work of repair. Considering how long the cable had been down it was not in a very bad condition. As to the reserve fund, it had been the wish of the proprietors that they should take counsel's opinion as to that fund. The whole of the case was laid before Mr. Kay, Q.C., of the Chancery Bar, with reference to the conflicting claims of the ordinary and preference shareholders, and the effect of the opinion of the learned gentleman was that the reserve fund belonged to both classes of shareholders, they being equally interested. This was a fund that they drew upon from time to

time, and which benefited both classes equally.—Mr. Field seconded the adoption of the report. He thought some steps should be taken to amalgamate with some more influential and powerful company.—Mr. Robinson made inquiry as to the Cyprus cable.—The Chairman said he should wish to charge all he could to the revenue for the half-year, keeping the reserve fund for other purposes. He could not tell what the expense of repairing the cable would be until the engineer had overhauled it and reported. He thought that now that we were extending our Empire in the East, the Company had a strong claim on the Government and as soon as he heard that Cyprus was to come under British protection he put himself in communication with the Government. At present he did not know what they had decided about the line from Alexandria to Cyprus. He had heard rumours, but he did not think that anything definite was settled. As regarded amalgamation, he had put himself in communication with another company, but he did not know what the result would be. The report and accounts were adopted, and the dividends declared.—A vote of thanks to the chairman closed the proceedings.

The ordinary general meeting of shareholders of the Cuba Submarine Telegraph Company was held on the 19th inst. at the offices of the Company, 61, Old Broad Street, Mr. Thomas Hughes, Q.C., in the chair. The particulars of the report presented to the meeting we published in our last issue. The Chairman said that shareholders would naturally be desirous to hear something about the repairs to their cable which had been executed during the past half-year. The cable was laid in April, 1870, and in October, 1873, an interruption took place which lasted for six months, and involved a loss of £20,000. The interruption which had recently occurred was practically as serious as the the first, but, owing to the policy which had been followed by the board, the cable had been cut and landed at Cienfuegos, but, owing to its having been duplicated all the way to Santiago, no loss had resulted from diminution of traffic. The total cost had been £12,600, and the interruption lasted only 45 days instead of six months, as on the previous occasion. To meet these contingencies, the directors had determined to lay by a sum annually, as it was impossible to tell when they might occur. This had been the policy of the directors from the first, and their object in now recommending a rather smaller dividend than usual was simply to enable them to add to the reserve fund. In his opinion they ought to be in such a position as to be able to lay down a new cable throughout, should that ever be necessary, and until that were arrived at he should not consider their affairs to be in a satisfactory condition. He had received letters from several large shareholders expressing approval of the policy of the board, and their readiness to accept the temporary diminution of dividend proposed. One gentleman stated that he trusted the dividend would not be increased beyond 6 per cent. until the reserve fund had been increased sufficiently to meet all contingencies. Directors had always encouraged communications from shareholders, and were pleased to hear their views, as it showed that they took an interest in the affairs of the company, and so strengthened the hands of the directors. The number of shareholders had increased from 100 at starting to 400 at the present time, and this proved that increasing confidence existed on the part of the public. Comparing the balance-sheet of the present half-year with that of 1877, he found that the traffic receipts had fallen from £19,500 to £18,300. There was no reason for supposing that was a sign of permanent depreciation. Most probably the traffic would speedily recover itself. The deficiency was to be accounted for by the change of tariff which the West India Company had felt themselves bound to make upon their line. This had not, in any sensible manner, deteriorated the number of messages, but it had had the effect of limiting the number of words in the messages, and the consequence was a considerable reduction in the traffic receipts. Mr. Keith, a most competent officer, had expressed himself satisfied with the condition of the cables generally, and he had just completed a very important work for their neighbours, the International Ocean Company. Their cable had been interrupted, and, having seen how successfully the repairs of the Cuba Company had been executed at the beginning of the year, they applied to Mr. Keith to take the control of their repairs. The directors were very pleased to accede to this, because it gave their officer greater experience in a very difficult part of the ocean for laying cables: for no more troublesome place existed for that purpose than the strait between Havana and the mainland. Moreover, it strengthened the good understanding between the two companies, and enabled the International Ocean Company to test and to prove the value of their repairing ship. Mr. Keith had now had experience of the ships of both their northern and southern neighbours, so that he might be expected to be able to meet any new difficulty which might possibly occur. Directors proposed to pay only six per cent. this half-year, and he trusted that shareholders would see the wisdom of the proposition. He moved that the report be received and adopted. This having been seconded, was, after some slight discussion, carried unanimously, and the meeting terminated in the usual manner.

The directors of the Indo-European Telegraph Company, Limited, have declared an interim dividend for the half-year ending June 30th last, at the rate of 5 per cent. per annum, free of income tax, payable on and after October 1st next. At the extraordinary general meeting of this company, mentioned in our issue of the 15th inst., the business was of a formal character, and the resolutions authorising the agreement to be carried out were adopted.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 60¾-61¼; Ditto, Preferred, 90½-91½; Ditto, Deferred, 33¾-34¼; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 9½-10; Cuba, Limited, 10 per cent. Preference, 16¾-17¼; Direct Spanish, Limited, 1-1½; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13-13¼; Eastern, Limited, 7⅛-7⅜; Eastern, 6 per cent. Debentures repayable October 1883, 105-108; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11⅜-11⅝; Eastern Extension, Australasian and China, Limited, 7⅜-7⅝; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109 xd.; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5¼-5½; Globe 6 per cent. Preference, 10¾-11½; Great Northern, 8⅜-8⅝; Indo-European, Limited, 20½-21½; Mediterranean Extension, Limited, 3-3⅛; Mediterranean Extension, 8 per cent. Preference, 9⅜-10½; Reuter's Limited, 10-11; Submarine, 228-233; Submarine Scrip, 2⅛-2⅜; West India and Panama, Limited, 2-2½; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited; 4¼-4⅜; Ditto, 6 per cent. Debentures "A," 93-96, Ditto, ditto, ditto, "B," 91-93; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds, 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30½-31; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅝-2⅞; India-Rubber and Gutta-Percha and Telegraph Works, Limited, 31-32.